CLAIMS

1. A method for processing at least one signal sent by a transmitter, said signal preferably being used for measuring the range, i.e. the distance between said transmitter and a receiver, said signal comprising a carrier signal modulated by a pseudo random noise (PRN) code, said method comprising the steps of :

- mixing said signal with a replica of the carrier signal, to acquire a baseband signal, representing said PRN code,
- multiplying said baseband signal respectively with M+N+1 PRN code replica's ($P_{-M},\dots,P_{+N}$), said replica's being shifted in time with respect to each other, the value M+N+1 being at least equal to four, one of said replica's being the punctual replica P_0,
- calculating the M+N+1 correlation values ($I_{-M},\dots,I_{+N}$) of said baseband signal with respect to each of said M+N+1 PRN code replica's,
- calculating from said M+N+1 correlation values ($I_{-M},\dots,I_{+N}$), an estimate of the multipath error, said calculation being based on a predefined formula, equating said multipath error to a predefined function of said M+N+1 correlation values ($I_{-M},\dots,I_{+N}$), wherein said predefined formula is a linear combination of said M+N+1 correlation values ($I_{-M},\dots,I_{+N}$), each of said values being normalized by the correlation value I_0 of said punctual replica P_0.

2. A method according to claim 1, comprising the steps of :

- mixing said signal with a replica of the carrier signal, to acquire a baseband signal, representing said PRN code,

- multiplying said baseband signal respectively with three equally spaced replica's (P_0, P_{-1}, P_{+1}) of said PRN code, namely an early (P_{-1}), punctual (P_0) and late (P_{+1}) replica, with a given early-late spacing (d),
- multiplying said baseband signal with at least one additional replica of said PRN code, said additional replica being shifted in time relative to said early, late and punctual replica's, so that in total M+N+1 code replica's are used, M+N+1 being at least equal to four,
- calculating the M+N+1 correlation values ($I_{-M}, \ldots, I_{+N}$) of said baseband signal with respect to each of the M+N+1 PRN code replica's,
- locking the punctual code (P_0) to the baseband signal by keeping the two correlation values (I_{-1}, I_{+1}) between said baseband signal and said early and late replica's (P_{-1}, P_{+1}) equal to each other,
- calculating the range by multiplying the delay of the punctual code (P_0) by the speed of light,
- calculating from said M+N+1 correlation values ($I_{-M}, \ldots, I_{+N}$), an estimate of the multipath error, said calculation being based on said predefined formula,
- filtering said estimate of the multipath error and subtracting said estimate of the multipath error from said calculated range, yielding a corrected range value.

3. A method according to claim 1, wherein said linear combination is of the following form :

$$MP = \sum_{i=-M..N} \alpha_i \frac{1}{I_0} \frac{I_i}{1-|i|\frac{d}{2}}$$

wherein MP represents the multipath error, d represents the early-late spacing, I_0 represents the correlation value of

said punctual replica , $I_{-M},\ldots,I_{+N}$ represent the correlation values, α_i represent M+N+1 fixed values.

4. A method according to claim 3, wherein every one of said M+N+1 replica's is shifted over the same time delay with respect to the next and/or previous replica.

5. The method according to claim 3, wherein said α_i values are calculated according to the method comprising the steps of :

- simulating, for a fixed signal-to-multipath amplitude ratio and for different multipath delays : the multipath range error and M+N+1 correlation values,
- using said simulated range errors and correlation values to obtain a system of equations, each equation equating the simulated multipath range error to a linear combination of the M+N+1 correlation values,
- obtaining said α_i values by solving said system of equations.

6. The method according to claim 5, wherein all except two of said α_i values may be set to zero.

7. The method according to claim 6, wherein said α_i values are calculated according to the method comprising the steps of :

- for a given signal-to-multipath amplitude ratio SMR and for a given number D of multipath delays, calculating the range error, for multipath in phase with a simulated line-of-sight signal and for multipath 180° out of phase with said simulated line-of-sight signal, thereby obtaining a vector y comprising 2D range error values,
- calculating, for each of the 2D range errors, the M+N+1 correlation values, and normalizing said correlation values by the correlation value I_0 of said punctual replica P_0, to obtain a (2D X (M+N+1)) matrix C,

- calculating the α_i values by solving the system of equations : $y=C.\alpha.$, wherein α is a vector comprising the M+N+1 α_i values.

8. The method according to claim 7, wherein the vector α is overdetermined by said system of equations and wherein said vector α is obtained by an optimization technique.

9. A method according to claim 3, wherein two replica's are used in the estimation of the multipath error, and wherein the early-late spacing (d) is 1/15 of a chip length, and wherein the second replica (P_{+2}) is 1/15 of a chip length later than said punctual replica (P_0), and wherein said multipath error estimation (MP) is calculated as :

$$MP = -0.42 \cdot \left(1 - \frac{I_{+2}}{I_0}\frac{1}{1-d}\right)$$

10. A receiver for ranging applications, said receiver comprising a plurality of channels for detecting and locking onto a plurality of PRN encoded signals, each channel comprising :

- a delay line, comprising M+N+1 taps, M+N+1 being at least four, for obtaining M+N+1 PRN codes, one of which is a punctual code P_0, one a first early code P-1, and one a late code P+1, with an early-late spacing d between the early and late code,
- M+N+1 mixers and M+N+1 accumulators to calculate M+N+1 correlation values ($I_{-M},\ldots,I_{+N}$),
- a multipath estimator module to calculate a multipath error estimate MP, according to a predefined formula, said formula being a linear combination of said M+N+1 correlation values ($I_{-M},\ldots,I_{+N}$), each of said values being normalized by the correlation value I_0 of said punctual replica P_0,

- a low pass filter.

11. The receiver according to claim 10, wherein said formula has the form :

$$MP = \sum_{i=-M..N} \alpha_i \frac{1}{I_0} \frac{I_i}{1-|i|\frac{d}{2}}$$

wherein MP represents the multipath error, d represents the early-late spacing, I_0 represents the correlation value of said punctual replica , $I_{-M},\ldots,I_{+N}$ represent the correlation values, α_i represent M+N+1 fixed values.

12. The receiver according to claim 11, wherein said α_i values are calculated according to the method comprising the steps of :

- simulating, for a fixed signal-to-multipath amplitude ratio and for different multipath delays : the multipath range error and M+N+1 correlation values,
- using said simulated range errors and correlation values to obtain a system of equations, each equation equating the simulated multipath range error to a linear combination of the M+N+1 correlation values,
- obtaining said α_i values by solving said system of equations.

13. The receiver according to claim 12, wherein all except two of said α_i values may be set to zero.

14. The receiver according to claim 13, wherein said α_i values are calculated according to the method comprising the steps of :

- for a given signal-to-multipath amplitude ratio SMR and for a given number D of multipath delays, calculating the range error, for multipath in phase with a simulated line-of-sight signal and for multipath 180° out of phase

with said simulated line-of-sight signal, thereby obtaining a vector y comprising 2D range error values,

- calculating, for each of the 2D range errors, the M+N+1 correlation values, and normalizing said correlation values by the correlation value I_0 of said punctual replica P_0, to obtain a (2D X (M+N+1)) matrix C,
- calculating the α_i values by solving the system of equations : $y=C.\alpha.$, wherein α is a vector comprising the M+N+1 α_i values.

15. The receiver according to claim 14, wherein the vector α is overdetermined by said system of equations and wherein said vector α is obtained by an optimization technique.

16. The receiver according to claim 11, wherein two replica's are used in the estimation of the multipath error, and wherein the early-late spacing (d) is 1/15 of a chip length, and wherein the second replica (P_{+2}) is 1/15 of a chip length later than said punctual replica (P_0), and wherein said multipath error estimation (MP) is calculated as :

$$MP = -0.42 \cdot \left(1 - \frac{I_{+2}}{I_0}\frac{1}{1-d}\right)$$

17. The receiver according to claim 10, wherein said multipath estimator module comprises software means for calculating the multipath error estimate on the basis of a predefined formula.

18. The receiver according to claim 10, wherein said multipath estimator module comprises hardware means for calculating the multipath error estimate on the basis of a predefined formula.

19. A method for estimating a ranging error due to multipath in a receiver, said receiver comprising :

- a delay line, comprising M+N+1 taps, M+N+1 being at least four, for obtaining M+N+1 PRN codes, one of which is a punctual code P_0, one an early code P_{-1}, and one a late code P_{+1}, with an early-late spacing d between the early and late code,
- M+N+1 mixers and accumulators to calculate M+N+1 correlation values ($I_{-M}, \ldots, I_{+N}$),
- a multipath estimator module to calculate a multipath error estimate (MP), according to the formula : $MP = \sum_{i=-M..N} \alpha_i \frac{1}{I_0} \frac{I_i}{1-|i|\frac{d}{2}}$ wherein MP represents the multipath error, d represents the early-late spacing, I_0 represents the correlation value of said punctual replica , $I_{-M}, \ldots, I_{+N}$ represent the correlation values, α_i represent M+N+1 fixed values,

said method comprising the steps of :

- simulating, for a fixed signal-to-multipath amplitude ratio and for different multipath delays : the multipath range error and M+N+1 correlation values,
- using said simulated range errors and correlation values to obtain a system of equations, each equation equating the simulated multipath range error to a linear combination of the M+N+1 correlation values,
- obtaining said α_i values by solving said system of equations.

20. The method according to claim 19, wherein all except two of said α_i values may be set to zero.

21. The method according to claim 20 comprising the steps of :

- for a given signal-to-multipath SMR and for a given number D of multipath delays, calculating the range error, for multipath in phase with a simulated line-of-

sight signal and for multipath 180° out of phase with said simulated line-of-sight signal, thereby obtaining a vector y comprising 2D range error values,

- calculating, for each of the 2D range errors, the M+N+1 correlation values, and normalizing said correlation values by the correlation value I_0 of said punctual replica P_0, to obtain a (2D X (M+N+1)) matrix C,
- calculating the α_i values by solving the system of equations : $y=C.\alpha.$, wherein α is a vector comprising the M+N+1 α_i values.